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INTRODUCTION AND STATION LIST

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arly 235 million square kilometres, or
y 65 %, of the whole ocean-bed lies at a
th of more than 2,000 fathoms (3,685
res) below sea-level. This area, which is
as large again as all the land-masses put
ether, can therefore unhesitatingly be
ignated as the largest faunal region in the
ld, while at the same time it is one of
most extreme from the point of view of
ditions of life. It is also probably one of
least investigated. Before the Swedish
p Sea Expedition, the number of catches
bottom-animals had amounted to little
re than a hundred or so, and most of them
reover had been obtained with relatively
all equipment (dredges, sledge-trawls and
m-trawls of rather small capacity), so that
knowledge of the bottom-fauna at depths
ater than 2,000 fathoms was very defective.
is applies especially to the larger and more
bile forms, above all the bottom-fishes, of
ich earlier expeditions had obtained only
out thirty species in a total of fifty specimens.
reover, the few investigations that had been
de had gone down to a depth of only 6,035
tres. Whether any living creatures can exist
greater depths, and especially in the so-called
eps», was completely unknown.[1])
t therefore seemed quite clear that a deep-
expedition that had at its disposal the
technical resources to carry out investigations at great depths with relatively large and effective bottom-equipment should be able to contribute considerably to our knowledge of the deep-sea bottom-fauna. It consequently seemed to me, as leader of the zoological investigations of the Swedish Deep Sea Expedition, not only a fascinating task but even more an imperative duty to give to the investigation of the bottom-fauna in deep water the largest possible space on the programme of work. Since, as I have already pointed out in my introduction, the originally limited time allocated to the zoological work had for various reasons to be reduced considerably, I did not hesitate to allot all the available time to research on the deep-sea bottom-fauna by means of trawlings at depths greater than 4,000 metres, although I was well aware that from the point of view of quantity we should have to reckon on very modest results from the research-work carried out.

As an introduction to the studies by various specialists of the animal material obtained by the deep-sea trawlings carried out by the expedition, I shall give here firstly a description of our trawling-technique, and secondly an account of the work carried out at each trawling-station, together with a brief description of the catches, mainly in accordance with the

) Recently I have however found a communication
A. Agassiz (1902 p. 60 and 77) dealing with a haul
h a small »Blake» trawl in a depth of 4,173 fathoms
7,631 m) at the U. S. »Albatross» St. 185, lat. 21° 18′ S,
g. 173° 31′ W, Nov. 27th 1899. »Deepest haul of
wl yet made. — — A half-gallon jar was filled with frag-
nts of a large siliceous sponge allied to Aulochene or
teromorpha which the »Challenger» obtained in shal-
lower water, in about 500 fathoms, in the western Pacific». This communication, which seems to have been overlooked by all later authors dealing with the deep-sea bottom-fauna, proves thus, that Agassiz has already made a successful attempt at trawling in a »deep», the Tonga deep. Whether the sponge mentioned really did live at that depth seems somewhat questionable; the find has obviously never been investigated by a specialist.

preliminary identification that was carried out on board, in order to give a general picture of the results of the various hauls. For the definitive identification, which is not yet available for more than a few species, the forthcoming specialist studies must be referred to. The accounts of our trawling-technique and of the individual hauls have perhaps been made too detailed, but this has been done in the hope that the information given may be of help and guidance to future deep-sea expeditions devoted wholly or in part to investigation of the deep-sea bottom-fauna.

It is a pleasant duty for me to express here my deeply-felt thanks to all the specialists who have so kindly undertaken both the study of the material, which is often very defective and difficult to identify, and also the task of tabulating, for their respective groups of animals, all the species hitherto known to occur at depths greater than 3,000 metres; for it seemed to me valuable to have available a complete tabulation of our present knowledge of the deep-sea bottom-fauna.

The zoological material collected during the Swedish Deep Sea Expedition has been presented by the expedition's committee to the Natural History Museum in Göteborg.

Equipment and Catching-Technique

Historical. Only a small portion of the rich and multifarious animal-life of the sea can be the object of direct observation. In particular, the direct observation of the fauna confined to the sea-bottom is for practical purposes limited to what the shore, drained by the ebbing tide, exposes to observation, and to what divers, with or without diving-suits, can observe and bring back to the surface. All knowledge of the organisms which exist down below must be acquired by indirect means, i. e. by studying what can be brought to light by fishing-tackle and other equipment for making catches, and by combining t results and the experience that are obtaina in this way. One consequence of this is th the choice of suitable equipment and the i provement of its efficiency, in other wo the technique of making catches, plays a de sive rôle in our knowledge of by far the larg part of the animal life of the sea, and ab all of the deep-sea. In consequence, impro catching-technique is one of the first conditi for further conquests in the domain of ma zoology.

The first expeditions to devote themse to research into the bottom-fauna in the g sea-depths all worked with relatively si equipment. Before the »Challenger» expi tion, the chief tool of marine zoology the dredge; thus the English expedition in »Porcupine» in 1869, the first expedition succeed in establishing the existence of an life at a depth of more than 2,000 fath used only dredges. But as work was suc fully carried out at greater and greater de it was found that the bottom-fauna t decreased in number, both of species an specimens, which made desirable the us larger and more efficient catching-equip for the greater depths. When the »Challe expedition was equipped, they did not to abandon the dredge, the efficiency of v was known; but the equipment for cat bottom-animals was supplemented by t trawls with apertures of from 16 to 20 and as the expedition progressed, they over more and more to the use of beam-t for work at great depths. Thus of the 75 carried out at a depth greater than fathoms, 53 were carried out with beam-t usually the smaller ones, and with these even obtained larger and more mobile an including bottom-fishes. The catches o however, were neither large nor numero of the trawls yielded catches of bo organisms, the deepest at 5,490 metre only 10 of them contained bottom-

esenting 13 different species in a total of pecimens. If, to afford a better comparison the results of the Swedish Deep Sea edition, we only consider the »Challenger's» hes from depths greater than 4,000 metres, figures then become, for 29 successful ls, 8 species of bottom-fishes in a total 6 specimens. In none of the ten successful lgings deeper than 2,000 fathoms were any om-fishes obtained.

hus the beam-trawl marked a decided ance in catching-technique, but it never- ess had the drawback that in deep water ften reached the bottom upside-down. To rcome this snag, the Americans SIGSBEE AGASSIZ constructed the well-known lge-trawl, which, with small variations, was d for deep-water trawling not only by the nerous American expeditions in the »Blake» l the U. S. »Albatross» in the Atlantic and Pacific, but also by the fruitful French edition in the »Talisman» in 1883, and by NCE ALBERT I OF MONACO on his many famous ntific expeditions. The size of this piece equipment has varied: the »Blake's» sledge- wl measured 3.5 metres between the run- s, the »Talisman's» from 2 to 3 metres, ile the apertures of PRINCE ALBERT's sledge- wls varied between 1.6 and 2.5 metres. e »Talisman» made six hauls deeper than 00 fathoms, the deepest between 4,975 and 05 metres, all successful, three of them with gether 3 species of fishes in a total of 5 cimens. During the PRINCE OF MONACO's editions, 37 hauls were made deeper than 00 fathoms, of which 22 made catches, the pest at 6,035 metres; five of these catches tained fishes, 7 different species with one cimen of each. Of the 37 hauls, 32 were de at depths greater than 4,000 metres, of them yielding catches, including among er things all the fishes just mentioned.

As can be seen, the catches of fishes at se depths with beam- and sledge-trawls re not large, and as a rule only small catches were made even of the lower bottom-fauna. One catch of the »Challenger's» is usually cited as being remarkably rich; this was made at St. 244 in the Pacific between Japan and Hawaii at a depth of 5,307 metres, and consisted of 1 sponge, 1 antipatharian, 6 actinians, 2 corals, 1 hydroid colony, 2 crinoids, 3 star-fish, 1 sea-urchin, 5 holothurians, many worms, 7 or 8 mussels, and a brachiopod.

A new and more effective instrument for marine research became available when the Danish zoologist C. G. JOH. PETERSEN introduced for scientific use modified versions of the otter-trawl. The use of this both for practical and for purely scientific fishery research was of enormous importance, and by means of it specimens were obtained of a number both of fishes and of lower animals that up to then had been completely unknown or had been considered exceptionally rare. Up to now, however, it has played a quite subordinate rôle in deep-sea research. It was used, it is true, on PRINCE ALBERT's expeditions, but principally at shallower stations, since it was considered far too big and heavy to be dragged at greater depths; during the 1905 expedition an attempt to use it at 3,465 metres was a failure, in that during that haul the trawl never reached the bottom; and after that the equipment was abandoned, as far as the greater depths were concerned, in favour of the old well-tried sledge-trawl (RICHARD 1907 p. 244).

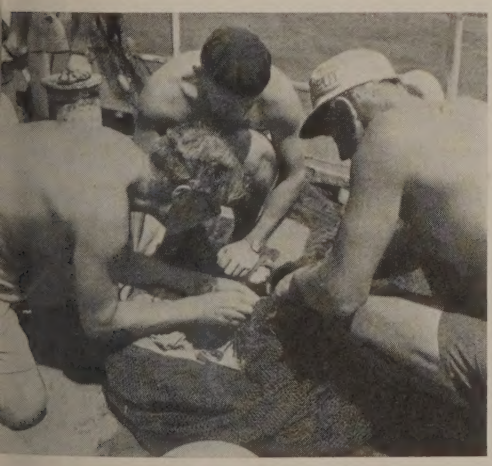
When the Norwegian fishery biologist JOHAN HJORT was faced with the task of organizing the Norwegian Atlantic Expedition in the »Michael Sars», he proposed as one of its objects to try whether a large otter-trawl could be used to catch, on what was then called the Abyssal Plain, i. e. the region deeper than 2,000 fathoms, more and perhaps even larger bottom-animals than had been possible for earlier expeditions with their relatively small beam- and sledge-trawls. For this purpose he chose a trawl with a fifty-foot headrope. To

avoid the use of twin-cables, which for one thing would have been much too heavy, and for another might easily have fouled one another and thereby caused technical difficulties during the hauling-up, the trawl was towed by bridles, as PETERSEN had done with smaller, pelagic trawls, i. e. the two lines from the otter-boards were made to run together to a common coupling at the end of a single cable, which could then be made the desired length. With this equipment, the »Michael Sars» expedition made a number of successful hauls with very good catches right down to 3,120 metres, where among other things they caught 21 bottom-fishes, and a large number of holothurians, echinids, asterids and ophiurids, as well as a number of decapodous crustaceans (see MURRAY & HJORT 1912, p. 420). Successful hauls were made, however, at even greater depths. Two hauls were made at St. 10, depth 4,700 metres, of which the first was successful, while during the second, after a $3^1/_2$ hour haul, the trawl stuck fast in the bottom. At St. 47, depth 5,160 metres, the trawling was unsuccessful: the trawl did not come up cleanly and brought up only an *Umbellula güntheri*. On the other hand, a further attempt at St. 48 (precise depth not mentioned, but at least 5,000 metres) was successful. I need not enter here into further details about these trawls and their catches, but reference may be made to HJORT's own account (MURRAY & HJORT 1912, pp. 62—63, 87—88 and 419), from which it is clear both that, despite the size of the equipment, the catches were very small, and also that the technical difficulties were considerable; it must also be pointed out that the strain on the blocks and swivels and on the cable was dangerously heavy during the deep trawls, especially when the trawl cut down into the bottom.

Equipment used by the Swedish Deep Sea Expedition. When the question arose of deciding on equipment for the marine zoological work of t Swedish Deep Sea Expedition, which, reasons given above, was to consist prima of research into the bottom-fauna at dep greater than 4,000 metres, especially bottom-fishes, it was apparent that we m select equipment of large catching-capaci In view of the considerable difficulties countered by the »Michael Sars» expedit with its 50-foot trawl, and considering also hazards of shooting such a bulky equipm from a ship of the size contemplated for expedition, I chose a 30-foot trawl with brid of the type used by Swedish and Norweg fishermen when they trawl for the pra *Pandalus borealis*. This trawl is not too to be shot direct from the vessel's stern ought, moreover, to put less strain on expensive cable if, as happened during Norwegian expedition, it should stick i mudbank; and finally, its rather fine m should enable it to retain even relatively s animals. After discussions with JOHAN HJ in person, it was further decided to adopt practice of »stropping up» the lower edg the net about 15 cm above the foot rope prawn-fishermen do, to avoid getting much clay or ooze in the catches. This c be expected to reduce the trawl's efficacy catching bottom-organisms on a hard bott but could, on the other hand, be a fur guarantee against the trawl's cutting d into the bottom and sticking in the ra loose sediments that could in general anticipated as the normal bottom for traw during the expedition.

To keep the mouth of the trawl as wi stretched open as possible, our fisher fasten a row of hollow glass balls alon upper edge. This arrangement cannot course be used for trawling in deep w since the glass balls are broken by the w pressure even at depths less than 1,000 me After various fruitless discussions on a suit design for deep-sea floats, it was found

l experiment that floats are in fact
fluous, provided that the otter-boards
xed close to the wings of the trawl.
trawl of the type briefly described above
tested during the 1946 trial expedition
ıe »Skagerak», and was found to work
lently except for a haul on a hard bottom.
ng others, we carried out a haul at a
h of 2,150—2,300 metres in Cadiz Bay,
near one of the »Michael Sars's» trawling-
ons (St. 25 B, depth 2,055 metres). At
somewhat shallower station, the Nor-
an expedition obtained 14 different species
shes (KOEFOED 1927), while we obtained
(NYBELIN 1947, 1948); but whereas the
hael Sars», with its larger trawl, obtained
tal of 33 specimens, we obtained 66, since
trawl, with its finer mesh, caught in
ition a large number of smaller specimens.
ilarly, we caught a number of lower ani-
s, such as starfish, brittle-stars, sea-urchins,
cucumbers, etc. which showed that the
opping up» of the trawl by no means
cluded the catching of lower bottom-
nals in cases where the bottom was not
d. As a result of these successful experi-
nts, I decided to use the prawn-trawl as the
ncipal piece of equipment for the Swedish



1. To increase the chances of the trawl's retaining
n small organisms, the bottom of the trawl-bag was
lined on the inside with fine-meshed cloth.
Photo Dr J. ERIKSSON.

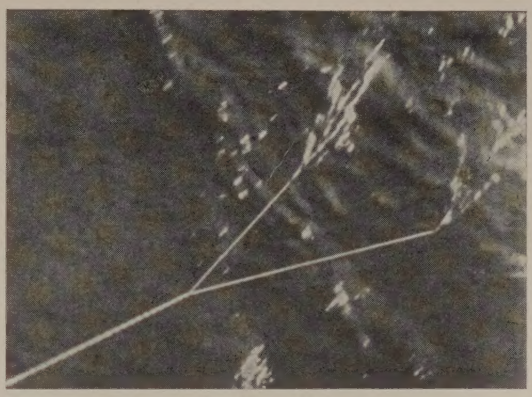


Fig. 2. During the first trawling the bridle-lines twisted round one another. From a moving film by Dr J. ERIKSSON.

Deep Sea Expedition's research into the bottom-fauna at great depths.

In this connection, some of the dimensions of the trawls used on the expedition may be of interest. The head-rope of the trawl was 11.4 metres long, while the distance from the middle of the head-rope to the backmost part of the bag was 8.2 metres. The size of the mesh was 20 mm from knot to knot in the wings, and 10 mm in the trawl-bag. The size of the otter-boards was 108×86 cm, with a thickness of 3.3 cm. To increase the chances of the trawl's retaining even small organisms, the bottom of the trawl-bag was lined on the inside with fine-meshed cloth (Fig. 1). The bridle-lines were 90 metres long. To prevent the cables from becoming twisted, swivels were placed both between the bridle-lines and their common coupling, and also between the latter and the main cable. Since it was discovered during the first haul that in spite of this the bridle-lines still twisted round one another from the common coupling to nearly half their length (Fig. 2), a stretcher was placed between them consisting of an iron tube about 40 cm long, as near the common coupling as possible (Fig. 3), and this had the desired effect.

The great merit of the otter-trawl lies in its great catching-capacity, especially where bottom-fishes and other large and mobile

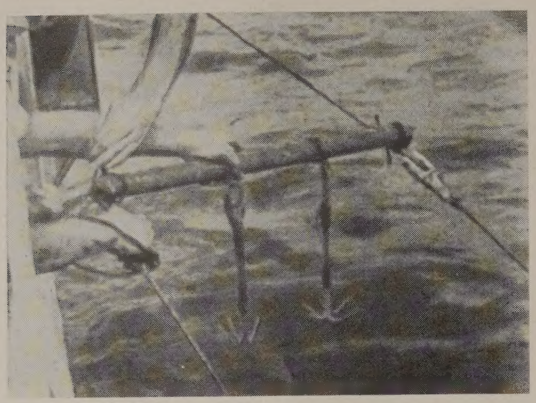


Fig. 3. To prevent the twisting of the bridle-lines a stretcher was placed between them as near the common coupling as possible; sometimes small drags were fastened to the stretcher. From a moving film by Dr J. Eriksson.

bottom-forms are concerned. It is of course this superiority to the earlier types of equipment more generally used that motivated its constant use during the Swedish Deep Sea Expedition. But this trawl is by no means an all-purpose equipment. The smaller bottom-organisms can easily escape through its relatively wide meshes, even with the additional arrangement of fine-meshed cloth at the backmost end of the trawl-bag, as described above. As a complement to the three trawls included in the expedition's equipment, we also took with us some smaller sledge-trawls, after the pattern designed by trawling-master A. Nilsson, which had been tested for the first time during the trial expedition in the »Skagerak» in 1946. Since this sledge-trawl is described and illustrated in the account of that expedition, and since, furthermore, owing to lack of time, it played only a subordinate rôle in the zoological collecting-work of the Swedish Deep Sea Expedition, I will content myself here with referring the reader to the above-mentioned publication (Nybelin 1947, pp. 4—5, fig. 1).

Sven Ekman (1947) has designed for the capture of certain bottom-organisms an equipment consisting of a number of drags that are trailed along the bottom attached to a cross-boom, and with this he has achieved excell results. He recommended me to use it our expedition, but unfortunately time did permit us to carry out any experiments w new equipment, especially in view of fact that, at the great depths we are h concerned with, the paying-out and heaving alone take many hours. Moreover, it seem very doubtful to me whether any catc worth speaking of would be retained on drags during heaving-in from a depth four or five thousand metres. For these reas no equipment of this type was obtained the expedition. On a few occasions, howe two drags made of wire were fastened to stretcher between the bridle-lines (Fig. 3), once a rich collection of bottom animals wa fact obtained on one of the drags (for furt details see below, under St. 387, Haul 13). shows that animals may very well be retai on a drag even after hauling-up from 4 metres, and I therefore strongly recomm the Ekman equipment for expeditions have the opportunity to devote time t alongside other types of equipment, whic cannot of course replace, but can with ad tage complement.

The older method of sounding the de of the oceans by mechanical means had resu in a very sketchy picture of the configura of the ocean-bottom. This applied espec to the very deep areas, where dense sound would have served no practical purpose. this reason, the bottom below a depth of 2 fathoms, apart from the »deeps», was consic to be a very nearly level or only sli sloping surface, the Abyssal Plain. But German »Meteor» expedition could alr establish with the help of dense echo-soun that, even at great depths, the bottom exhibit considerable variations in level w a limited area; and the self-recording sounder, which was used extensively d the Swedish Deep Sea Expedition, sh that even below 2,000 fathoms the ocea

no means a more or less plane surface, hat it is on the contrary often extremely en right down to the greatest depths. the point of view of marine zoology, is of the greatest consequence, inasmuch level bottom is one of the most important quisites for a successful haul. It appears mprobable that many failures with deep- r dredgings and trawlings by earlier ditions may simply have been due to act that they happened quite unknowingly w the equipment over a sharply broken om. I am thinking particularly of the hael Sars's» second haul at their St. 10, e the trawl stuck fast in a mud-bank. Such lents can now be almost entirely avoided, far as a self-recording echo-sounder is lable; with its help, the contours of the om on a given stretch can first be examined the distance requisite for a haul plus the nce required for paying-out, and then, e bottom is found to be level, a haul can arried out in the reverse direction, with tant attention to the reading of the echo- der. If, through drift, a more broken or ply sloping bottom happens to be encount- l, the haul can be broken off, and, since trawl is being dragged a long way astern he ship, it can be lifted from the bottom re it reaches the irregularities.

he continuous indication of the depth by self-recording echo-sounder during the l itself is an at least equally important antage from the purely biological viewpoint. viously, when bottom-animals were caught, usually had to content oneself with a nding taken before the dredging or the wling, and at the best a further sounding taken after the haul had ended, but hing could be known with certainty about actual depth reached by the equipment, or other words about the actual depth at ich the animals obtained had really lived. first time this method was used for getting ct information about the depth of a haul in deep water was, to the best of my knowledge, during the trial expedition in the »Skagerak» in 1947, at lat. N 35° 43′ long. W 8° 16′. Here, the depth when the trawl was lowered was 1,975 metres, which, if a self-recording echo-sounder had not been available, would presumably have had to be reckoned as the depth of the catch. The echogram, however, showed that, during the time when the trawl can be calculated to have been on the bottom, the depth was in reality 2,150—2,300 metres. Because of the gentleness of the slope, the demonstrable difference in depth was not, on this occasion, particularly great, probably less than in many earlier unchecked (and now, of course, uncheckable) statements of depth. Since, during all the trawlings on the Swedish Deep Sea Expedition, we maintained, with the help of the echo-sounder, a continuous check on the depth during the whole time the equipment was towed over the bottom, our figures for depths have achieved a high degree of accuracy; for, at the depths we are here dealing with, the reading of the echo-sounder, after the proper corrections have been applied, can be considered accurate to ± 15 metres. It is perhaps necessary to point out that, when the echogram is read, consideration must be paid to the distance the trawl lags astern of the ship. Consequently, the figures given for depths refer to the points astern of the ship where the trawl is calculated to have been at the instants when it respectively reached and left the bottom, and do not refer to the depths under the ship's keel that were registered by the echo-sounder at those instants.

Another technical problem during deep-water trawling is to decide on the length of cable required. Up till now, this has probably often been a matter of experience and judgment, without people having had any exact calculations to go by, and this has certainly been the cause of many failures. Too short a cable, of course, means that the trawl never reaches the bottom, while too long a cable,

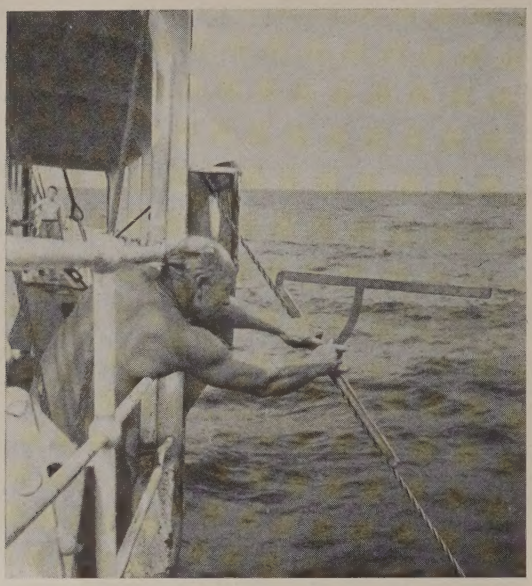


Fig. 4. Checking the angle of the cable. Photo Dr J. Eriksson.

apart from the loss of time in paying-out and heaving-in the equipment, leads to unnecessary, and sometimes disastrous, wear and tear on the part of the cable that drags along the bottom. Concerning this important detail, Dr B. Kullenberg made, during the expedition, calculations of the resistance offered to the water by both the trawl and the cable at various speeds, and on this basis drew up diagrams showing the length of cable needed for different depths at a certain given speed. By continuous observation of the angle the cable makes with the vertical at the side of the ship (Fig. 4), it is possible to decide when the trawl reaches the bottom, whether it follows the bottom during the haul, and when it leaves the bottom during the hauling-in. Since Dr Kullenberg has had the kindness to promise to give a particular account of his calculations, I need not enter further into this matter, but can refer the reader to Dr Kullenberg's own exposition.

With the help of the self-recording echo-sounder and the diagrams drawn up by Dr Kullenberg, we have been able to carry out our trawlings at great depths with accuracy hitherto unattained. In consequen it can be indicated that, thanks to our exp ments and experiences, the technical proble of deep-trawling have in principle been solv which will be of advantage to future biologi deep-sea research; this does not, of cou prevent the occurrence of failures as a res of an unsuitable bottom, or the occure of occasional mishaps, and such failures mishaps did in fact occur during the expediti

As to the practical methods of carrying our trawling, the following information can given here.

To reduce the risk of the ship's drifting, to make it easier to moderate its speed, hauls were carried out against the wind. investigation of the contours of the bott with a view to trawling was therefore alw carried out down-wind, after which trawl was carried out in the reverse directi consequently, on occasions when the sh course coincided with the direction of wind, the reconnoitring of the bottom co be carried out during the normal progres the ship. The distance required for lowe the trawl and for the haul itself is of co dependent on the depth, as well as on time the haul lasts and on the ship's sp during that time; since as a rule we wo at a depth of between 4,500 and 5,900 me and usually trawled for 4 hours at an ave speed of 1.5 to 2 knots, a distance of fro to 10 nautical miles with an even bottom considered necessary for each haul. W such a stretch had been traversed, co was laid in the reverse direction and trav started. The trawl was lowered direct the after-deck, and, when the otter-bo had swung out to the correct position, bridle-lines were paid out and secure means of shackles to the main cable, which the stretcher for holding the b lines apart was fixed in position. Ther main cable was run out, at first very sl

hen by successive accelerations to a rate
ween 0.7 and 0.8 metres a second, until
quisite length of cable (according to the
ENBERG diagram) had been reeled out.
this had been done, a dynamometer
ttached to the cable, and the tension
ad off every five minutes, until an increase
sion revealed that the trawl had reached
ottom. Then trawling was carried out,
y at a speed of $1^2/_3$—$1^3/_4$ knots, for four
reckoned from the conclusion of unreeling,
ded that the echo-sounder, which was
e the whole time, did not indicate such
es in the configuration of the bottom as
cessitate the earlier raising of the trawl
the bottom. During the first period of
auling-in, the winch was stopped every
inutes for the dynamometer reading to be
, until it registered a somewhat reduced
n, showing that the trawl had left the
m, after which the dynamometer was dis-
cted and hauling-in continued at an ave-
rate of 0.4 metres per second, until the trawl
ed the surface. Because of the negligible
t of the catches, the trawl could then
ted on to the deck by hand (Fig. 5).

Fig. 5. Because of the negligible weight of the catches, the trawl could be lifted on to the deck by hand. Photo Dr J. ERIKSSON.

The Trawling Operations

is known, the deep area of the Atlantic
n is divided by the Central Atlantic
e, running more or less parallel with its
s, into an easterly and a westerly deep
, for the most part more than 4,000
es deep (see the map appended). Earlier
tigations of the bottom-fauna in the N.
ntic at depths greater than 4,000 metres had
almost exclusively devoted to the eastern
, above all to its most northerly section. In
west they had been confined to the tracks
he »Challenger» expedition, plus a few
ons visited by the American expeditions
he east coast of N. America; on the other
, in the whole deep-sea area west of the
ral Ridge between the equator and the West Indies, no investigations had so far as I know been undertaken.

The Swedish Deep Sea Expedition's last Atlantic lap, during which the marine zoological work was to be carried out, was planned to run from the Straits of Gibraltar southwards through the eastern part of the Atlantic, down to the Romanche Deep immediately south of the equator, from there westwards over the Central Ridge, and then northwestwards to St Thomas in the West Indies, after which the route was to run north-east back to Sweden; and in this way the deepest areas of the N. Atlantic would be traversed. Since it was to be reckoned that during this voyage at least 16 trawlings would be carried out, the following preliminary programme was drawn up for them.

1 s t s t a g e : Straits of Gibraltar through the eastern Atlantic to the Romanche Deep. As, thanks to earlier investigators, this part of the Atlantic was the best-known, and as it was

desirable to keep as much time as possible for trawlings west of the Central Ridge, especially in the region of the greatest depths, only four hauls at the most were to be made on this stage. The purpose of these would be partly to gain experience in trawling-technique, partly to provide a comparison with the results obtained by previous expeditions.

2nd stage: Across the Central Ridge to the West Indies. It was considered that in this region, which, as stated above, had not been touched by earlier investigators, and which, because of the somewhat lower temperature of its bottom-water, presented somewhat different hydrographic conditions, at least four hauls should be carried out, spread over the whole stretch. Even a fragmentary knowledge of the bottom-fauna living here seemed to offer opportunities for interesting comparisons with the corresponding fauna east of the Central Ridge, which might of course present a more or less effective barrier to the deep-sea fauna on either side. It also seemed of interest to try to find out if the somewhat different hydrographic conditions, especially the lower temperature, could be thought to affect the character of the fauna.

3rd stage: the great deep areas N and NE of the West Indies. Since it was only here that it would be possible to attempt trawlings at depths greater than those at which earlier expeditions had worked, and our expedition might consequently be able to achieve here results of value for a knowledge of the depths down to which animal life can go, four hauls were assigned to this comparatively limited area.

4th stage: the voyage home. During this, 3 or 4 hauls were if possible to be carried out at different depths west of the Central Ridge, to obtain additional material for the comparison of bottom-fauna in the western and eastern deep areas; insofar as time might permit, at least one trawling was also desirable in the most northerly part of the eastern deep area.

After a short stay in Tangier, the exped started out from there on June 12th. I wa to establish the first trawling-station at bend of the 4,000-metre line that stret in towards Cadiz Bay, in order to extend deeper water the investigations that had made here earlier by the »Challenger», »Michael Sars» and the »Skagerak» at diff depths from 140 down to 2,300 metres. Wea conditions, however, did not permit of trawling here. Not until June 16th had wind dropped to strength 3 (Beaufort Sc and as, according to the echo-sounder, bottom was even, with a depth of a 4,320 metres, it was decided to make first attempt at trawling here.

Stat. 313. Haul No. 1. Date, June 1948. Wind NE, 3 Beaufort; current a 0.3 knots, direction 240°.

Check of Bottom: Covered a stre 8 nautical miles on course 211° true, d which the echo-sounder indicated an bottom between 4,320 and 4,290 metr

3.30 p. m. Position N 29°48′ W 17°

3.45 p. m. Shot the trawl (trawl no. 1); c first the »reverse course» (31°), later 4 account of change in direction of wind. out experimentally 6,500 metres cable, rate first of 0.4 metres per sec., later g ally increased to 0.7.

7 p. m. Cable out; depth at trawl 4,273 m

7.30 p. m. Trawl calculated to be on bottom; depth of trawl 4,267 metres. during trawling 1 to 1.5 knots.

11 p. m. Heaving-in begun.

11.50 p. m. Dynamometer reading ind that trawl had left the bottom; depth 4,255 metres.

4.25 a. m. (June 17th) Hauling-in of completed.

4.35 a. m. Trawl on deck.
Position N 30° 05′ W 17° 18′.

Depth: From the echogram (after c tions) the trawl can be reckoned to

ıe over an even bottom between 4,267
d 4,255 metres, and to have been on the
ttom about $4^1/_2$ hours.

ure of Bottom: Yellowish Globi-
ina ooze on the otter-boards, no bottom-
ıterial in the trawl except a few clinkers
d pieces of coal. The trawl had con-
quently been on the bottom.

tom water (St. 314, N 29° 48′
17° 27′, June 17th 7.20—9.40 a. m.):
epth 4,290 metres, Temp. +2.42° C., Sa-
inity 34.89 ‰, O_2 5.40 ml/L (sample taken
metres above bottom).

ch: According to the preliminary iden-
fication, there were obtained in this first
aul 12 bottom-fishes [*Bathysaurus mollis*
ÜNTHER 1 specimen, *Bathymicrops regis*
JORT & KOEFOED 2 specimens, *Nematonu-*
s armatus (HECTOR) 2 specimens, *Chalinura*
sp.? 5 specimens, one of which very small,
rotulid 1 specimen]; and of bottom-inverte-
rates: 3 holothurians; one *Munidopsis*-like
ecapodous crustacean, white with orange-
d eyes; 3 polychaete worms, probably
species.

Of pelagic organisms were obtained a
umber of fishes, including *Cyclothone*, *Argy-*
pelecus, *Sternoptyx;* a leptocephalus; various
oung fish; large red prawns of several
pecies; and a number of other pelagic
ıvertebrates.

his first attempt of ours at trawling in
p water must therefore be counted as
lly successful, and the length of cable ex-
mentally paid out, 6,500 metres, must
sequently have been about right. During
hauling-in of the cable, however, it became
r that three to four hundred metres of
le had trailed on the bottom — that the
le, in other words, had been unnecessarily
g. It was then that Dr KULLENBERG's
rest was aroused in the possibility of
rmining by direct calculation the requisite
gth of cable for each trawling-operation.

As early as the 19th of June, an even bottom was again found, at a depth varying from 4,670 to 4,710 metres (St. 317). The trawl was lowered, but when about 2,200 metres of cable had been paid out there was a 10 minutes' breakdown in the ship's engines. After 20 minutes' run, during which we gradually tried to get back on course, there was another breakdown for 10 minutes, and the ship again drifted down-wind. As I suspected that the trawl had fouled as a result of the manoeuvres during and after the breakdowns, it was hauled in again. It came up completely fouled, with the bridle-lines twisted and the otter-boards close together. No new attempt was made here, and the voyage was continued in a south-westerly direction.

Two days later, however, a new opportunity for trawling presented itself.

Stat. 319. Haul No. 2. Date, June 21st 1948. Wind ENE, 3 Beaufort; current negligible.

Check of Bottom: not necessary, as the bottom had, for at least the last 12 hours steaming towards this station, been very flat, about 4,900 metres deep, and trawling could take place on approximately the reverse course.

2 p. m. Position N 22° 31′ W 23° 28′.

2.05 p. m. Shot the trawl (trawl no. 1); course N 47° E. Paid out 7,000 metres cable, rate first 0.4 metres per sec., later gradually increased to 0.7.

5.25 p. m. Cable out; depth at trawl about 4,877 metres.

5.30 p. m. Trawl calculated from dynamometer-reading to be on the bottom; depth of trawl 4,872 metres. Speed during trawling about 1.5 knots.

9.25 p. m. Hauling-in begun.

9.35 p. m. Trawl calculated from dynamometer-reading to have left the bottom; depth at trawl 4,867 metres.

2.30 a. m. (June 22nd) Hauling-in of cable completed.

2.40 a. m. Trawl on deck.

Position N 22° 41′ W 23°10′.

From the echogram (after correction), the trawl can be reckoned to have traversed an even bottom between 4,872 and 4,867 metres, and to have been on the bottom for $3^3/_4$ hours.

Nature of Bottom: Yellowish Globigerina ooze on the otter-boards; no bottom-material in the trawl except a few small pieces of coke. Bottom harder than at the previous trawling-station.

Bottom water (St. 319, N 22° 31′ W 23° 28′, June 21st 11.08 a. m. — 1.45 p. m.): Depth 4,935 metres, Temp. +2.45° C., Salinity 35.03 ‰, O_2 5.26 ml/L (sample taken 6 metres above bottom).

Catch: According to preliminary identification there were obtained 3 bottom-fishes [*Chalinura carapina* (Goode & Bean) 1 specimen, *Chalinura* n. sp.? 2 large specimens, the larger 77 cm long]; and of bottom invertebrates one annelid and one sponge, somewhat suggestive of a *Funiculina* colony.

Of pelagic organisms were obtained a number of fishes, apart from the commoner species (*Cyclothone*, *Argyropelecus*, *Sternoptyx*, *Chauliodus*); a couple of deep-sea anglerfishes (*Melanocetus*, *Gigantactis*); a leptocephalus; various young fish; larger and smaller red prawns; a *Spirula* and another little cephalopod; etc.

The very small catch of bottom-invertebrates must have been due to the fact that the bottom here was harder than at the previous trawling-station.

After some days' interval at St Vincent in the Cape Verde Islands, course was set over the great deep-area, the Cape Verde Basin, in which the Prince of Monaco's record deep haul with a sledge-trawl was carried out, at 6,035 metres. Time did not permit us, however, to search for this deep: our course had to be laid more to the south. At first we encountered very uneven bottom, but at and after St. 3 on July 3rd the bottom-contours settled do at a depth of about 5,645 metres, and so decided to try a trawling.

Stat. 329. Haul No. 3. Date, July 1948. Wind ESE, 1 Beauf., increas during trawling to 2 Beaufort, with rain current.

Check of Bottom: Sailed up a strech 10.5 nautical miles in direction 140° t during which the echo-sounder registere practically even bottom between 5,645 5,590 metres.

4 p. m. Position N 09° 38′ W 26°.20′.

4.05 p. m. Shot the trawl (trawl no. 1); a measurements of tension, etc, began to out the main cable at 4.55 p. m.; course »reverse course». Paid out 7,800 metre cable, rate at first 0.4 metres per sec., l gradually increased to 0.8.

8.10 p. m. Cable out; depth at trawl a 5,620 metres.

8.40 p. m. Estimated from the dynamom that the trawl was on the bottom; dept trawl 5,610 metres. Speed during trawn about 1.5 knots.

Midnight: As the echogram indicated an even bottom, hauling-in was begun.

12.10 a. m. (July 4th) Estimated from dynamometer that the trawl had left bottom; depth at trawl 5,600 metres.

5.45 a. m. Hauling-in of cable completed.

5.50 a. m. Trawl on deck.

Position N 09° 50′ W 26° 30′.

From the echogram (after correction) trawl can be reckoned to have traverse even bottom between 5,610 and 5,600 m and to have been on the bottom for $3^1/_2$ h

Nature of Bottom: Calcareous red (probably the same as at St. 328) was f on the cable close to the bridle coup no bottom-material in the trawl except piece of coal and one piece of coke.

tom-water (St. 328, N 10° 12′ W
30′, July 2nd 10.50 p. m. — July 3rd
a. m.): Depth 5,360 metres, Temperature
2.35° C., Salinity 34.87 ‰, O_2 5.56 ml/L
mple taken 3 metres above bottom).

ch: According to the preliminary iden-
cation, there were obtained 22 bottom-
ıes (*Bathypterois* sp. 11 specimens, all
re or less defective; small Macrourids,
pecimens, all defective, some extremely so;
imaldichthys profundissimus ROULE 1 spe-
nen; *Bassozetus* sp., 1 specimen, small;
ucochlamys sp., 1 specimen; large Brotu-
(?), 1 specimen, badly defective). Of
ttom-invertebrates can be mentioned: ho-
hurians, a dozen, various species; 10
ırfishes (*Styracaster* and *Porcellanaster*); 63
ittle-stars, one species; *Bathycrinus* sp., 1
ecimen without stem; polychaetes; Acti-
an (?), 1 specimen; and fragments of silice-
ıs sponges.

Of pelagic species, the trawl contained,
sides the commoner species of small
hes, a beautiful *Monognathus* sp., one
seudoscopelus sp., a small male ceratiid,
rious decapods and other crustaceans,
large cephalopods (3 species), and a number
smaller cephalopods (several species).

his haul, up to that time the second-
est ever made in the North Atlantic, thus
ded a surprisingly rich catch of bottom
rtebrates: as far as I could discover, it
far richer in individual specimens than any
er haul carried out below 4,000 metres.
or bottom-fishes, the number of specimens
greater than all those caught in the North
ntic below 4,000 metres by all previous
editions put together, which can be taken
proof of the efficiency of the equipment
cted. Unfortunately, however, several of the
om-fishes were badly damaged in the
l during the long period of hauling in,
ly six hours; this applied especially to the
imens of *Bathypterois*, with their produced fin-rays and their loose jaws. On the other hand, it was a special satisfaction to catch a *Grimaldichthys profundissimus* ROULE, previously obtained in only one specimen, during PRINCE ALBERT's record deep haul with his sledge-trawl; for the fact that it had now also been caught in the second-deepest haul in the Atlantic further confirmed its character as an extreme deep-water fish.

Course was now laid towards the Romanche Deep, where the sharply broken bottom precluded any possibility of trawling at great depth. When the planned investigations had been completed there, we went northward again, looking for a suitable bottom for a haul, for I thought it would be valuable to carry out a trawl immediately north of the hypothetical Romanche Gap where the cold bottom-water breaks through. On the evening of July 15th, the echo-sounder revealed a level bottom at about 5,400 metres for about one hour's sailing on course 314° true, after which the bottom became uneven again. This course was continued until 1.10 a. m. the following morning, when we turned on to the reverse course and everything was prepared for trawling.

Stat. 342. Haul No. 4. Date, July 16th 1948. Wind SE by S, about 3—4 Beaufort. Current 350°, about 1 knot.

Check of Bottom: carried out while steaming over the station.

1.50 a. m. Shot the trawl (trawl no. 1); course 120° true. Paid out 7,350 metres of cable, rate at first 0.4 metres per sec., increasing to 0.7.

4.50 a. m. Cable out.

6 a. m. Calculated that trawl had reached locality where bottom level; paid out a further 150 metres cable until 6.20 a. m.; speed of the ship reduced.

6.30 a. m. Estimated from the dynamometer that the trawl was on the bottom; depth of the trawl 5,250 metres. Position

N 01° 03′ W 18° 40′. Speed during trawling 1.5—2 knots.

10.24 a. m. Hauling-in begun.

10.35 a. m. Estimated from the dynamometer that the trawl had left the bottom; depth at the trawl 5,300 metres.

Position N 00° 58′ W 18° 37′.

4.30 p. m. Hauling-in of cable completed.

4.35 p. m. Trawl on deck.

From the echogram (after correction) it can be reckoned that the trawl travelled over an even bottom between 5,250 and 5,300 metres and was on the bottom for four hours.

Nature of Bottom: According to the EKMAN core-sampler (240 A), fairly loose argillaceous Globigerina ooze; no bottom-material in the trawl except one piece of coal and one piece of coke.

Bottom water (St. 342, N 00° 59′ W 18° 37′, July 16th 7 p. m. — 9.26 p. m.): Depth 5,260 metres, Temp. +2.28° C., Salinity 34.85 ‰, O_2 5.47 ml/L (sample taken 7 metres above bottom).

Catch: According to the preliminary identification, there were obtained 6 bottom-fishes [*Bathymicrops regis* HJORT & KOEFOED, 4 specimens, *Chalinura carapina* (GOODE & BEAN), 1 specimen, *Porogadus* sp. 1 specimen]; and of bottom invertebrates a large violet-red holothurian (*Euphronides* sp.?), and one specimen each of two other species of holothurian; 25 starfishes (»*Styracaster*» sp. 6 specimens, »*Hyphalaster*» sp. 17 large and two small specimens, and an arm-fragment of a Brisingid); 2 species of mussels, 1 specimen of each, and fragments of shell; a few tubes of polychaetes; several large and small *Umbellula* sp.; 2 antipatharians; several different siliceous sponges; etc.

Of pelagic species there were caught various small fishes and fry; a *Barathronus* sp., ♀ with embryos, had probably also been caught in the intermediate depths, and similarly several species of red prawns, larger and smaller, one larger and one small cephalopod, and several other pelagic forms including *Pyrosoma*.

With this successful haul, the trawlings of the first stage were completed, and course was set westward over the Central Ridge. Quite unexpectedly, we there found on the evening of July 19th, for a $3^1/_2$ hours' stretch a remarkably even bottom at a depth of 4,000 to 4,075 metres, on course 275° true. Position N 00° 20′ W 26° 57′ (Stat. 346). At midnight we put about to a course of 85° true, and the trawl was lowered at 1.50 a. m. on July 20th. During lowering, the echo-sounder revealed after a time that the bottom became very uneven, and was rapidly becoming shallower, and so the paying-out of the cable was stopped at 3.30 a. m., when 3,000 metres of cable was out. Since at 4 a. m. the bottom still showed no sign of becoming even, the attempt was abandoned, and the trawl reached the deck at 5.28 a. m.. Our position was then N 00° 19′ W 26° 48′. The trawl contained a number of pelagic organisms, and can be considered to have gone to a depth of about 1,800 metres. It transpired later that, owing to a misunderstanding, our course had not been 85° true for the first 20 minutes of paying-out, which was the reason why the bottom was not re-encountered. The area we had come across was probably a depression of limited width.

After the Central Ridge had been crossed an even bottom was encountered at a depth of about 4,580 metres, during several hours steaming, and so it was decided to make the first trawling-station west of the Central Ridge.

Stat. 353. Haul No. 5. Date, July, 1948. Wind SE, 2 Beaufort; current W about 1/2 knot.

Check of Bottom: carried out steaming towards the station.

2.50 p. m. Position N 00° 15′ W 33

6). m. Shot the trawl (trawl no. 1). Paid
n 6,350 metres of cable, at a rate of 0.4
n res per sec., gradually increasing to 0.8.
6). m. Cable out.
5). m. Estimated from dynamometer that
r vl on the bottom; depth of trawl 4,570
n res. Speed during trawling not constant,
veen 1/2 knot and 2 knots. During
vling, repeated rain-squalls, 5—6 Beau-
.
2 p. m. Began hauling-in.
3 p. m. Estimated from dynamometer that
vl had left bottom; depth at the trawl
70 metres.
a. m. (July 24th) Hauling-in of cable
pleted.
a. m. Otter-boards and front portion of
wl on deck; the whole of the
awl-bag completely miss-
g.
sition N 00° 16′ W 33° 25′.
ure of Bottom: Loose clay.
Apparently the trawl got filled with
tom-material and burst under the strain.
the meshes of the portion of the trawl
t remained were only a couple of *Pyro-*
a, and no bottom-animals.
l No 5, consequently, was
complete failure.

July 26th, during the afternoon, an
ually even bottom was observed on course
true at a depth of between 4,467 and
metres, and it was therefore decided to
pt a further trawling.

357. Haul No. 6. Date, July
h—27th 1948. Wind E 1/2 N, 2—3
aufort; current negligible.
ck of Bottom: carried out while
aming towards the station.
m. Position N 02° 26′ W 39° 26′.
p. m. Shot the trawl (trawl no. 2); course
° true. Paid out 6,200 metres of cable,
a rate first of 0.4 metres per sec., in-
asing to fully 0.8 metres per sec.

10.31 p. m. Cable out.

11.05 p. m. Estimated from the dynamometer that the trawl was on the bottom; depth of trawl 4,474 metres. Speed during trawling about $1^1/_2$ knots.

1.33 a. m. (July 27th) Began hauling-in, since the echogram showed a reduced depth. Estimated that the trawl left the bottom at a depth of 4,430 metres. No dynamometer readings during hauling-in.

6.45 a. m. Hauling-in of cable completed.

6.55 a. m. Trawl on deck; whole trawl twisted inside-out and tangled up.

Position N 02° 24′ W 39° 12′.

From the echogram (after correction), the trawl can be reckoned to have traversed a bottom between 4,474 and 4,430 metres, at first flat, and during the last half-hour sloping, and can be reckoned to have been on the bottom somewhat less than 3 hours.

Nature of Bottom: Loose calcareous clay: no bottom-material in the trawl except a number of large and small pieces of clinker and a couple of pieces of coal.

Bottom Water (St. 357, N 02° 25′ W 39° 17′, July 27th, 7 p. m.): Depth 4,445 metres, Temp. +1.28° C., Salinity 34.77 ‰, O_2 5.11 ml/L (sample taken 4 metres above bottom).

Catch: On account of the trawl's being twisted, the greater part of what had certainly been a very fine and rich catch was probably lost; a large reddish holothurian was seen to fall back into the water just as the trawl was raised above the surface. The bottom-animals fixed in the meshes of the trawl consisted exclusively of invertebrates: 6 holothurians, probably 3 to 4 different species; 5 starfishes (»*Thoracaster*» sp.); one large brittle-star; one large *Umbellula* sp.; one sponge; and various organisms attached to the pieces of clinker.

Of pelagic organisms there remained:

Sternoptyx diaphana HERMANN, 4 specimens; one defective *Cyclothone*; various species of prawn; and one nemertean.

As fas as can be judged, the trawl got twisted towards the end of the hauling-in, quite near the surface; through a misunderstanding, the ship then came to a stop, so that the bridle-lines hung vertically downwards, whereupon the high swell that was then running probably caused the fatal twisting of the trawl-bag.

During the next few days, the bottom remained very level, gradually getting deeper. On August 2nd, we decided to carry out another trawling.

Stat. 362. Haul No. 7. Date, August 2nd 1948. Wind ESE, gusty, later moderating; current WSW, 0.8 knots.

Check of Bottom: 3.15 a. m. depth about 5,010 metres; sounding on course 310° true. 5 a. m. depth about 5,000 metres, then again rather deeper. Continued until 6.40 a. m. Position N 11° 45′ W 51° 29′.

7 a. m. Shot the trawl (trawl no. 2); course 90° true. Paid out 6,700 metres of cable, at a rate at first of 0.4 m. per sec., then increasing to 0.7.

10.36 a. m. Cable out.

11.05 a. m. Estimated from dynamometer that the trawl was on the bottom; depth of trawl 5,017 metres. Speed during trawling $1^1/_2$—$1^3/_4$ knots.

12.34 p. m. Since the tension recorded by the dynamometer appeared to increase alarmingly, and we feared a repetition of Haul No. 5, we began hauling-in so as to raise the trawl from the bottom.

1.05 p. m. Trawl considered to have left the bottom. Depth at trawl 5,010 metres. Hauling-in discontinued for the time being.

1.37 p. m. As the tension showed no sign of diminishing, and we did not want to risk bursting the trawl, the final hauling-in was begun.

7.10 p. m. Hauling-in of cable completed

7.24 p. m. Trawl on deck.

Position N 11° 44′ W 51° 09′.

The trawl contained only pelagic organi and there was nothing to indicate that it been on the bottom. From a closer stud the tension and angle records, undert after the haul, it appears that the t cannot have been on the bottom for than 20 minutes, and perhaps not at all is probable that, because of the difficult estimating the state of the current, our gro speed was greater than we had reckoned, so too great in relation to the length of used. In consequence, the h was a complete failure.

Since on the following morning the bo was still even, with a constant depth of a 5,040 metres, on course 310° true, we de to repeat the previous day's trawl but w longer cable.

Stat. 363. Haul No. 8. Date, A 3rd 1948. Wind ESE, 1 Beaufort; cu negligible.

Check of Bottom: carried out steaming towards the station.

9 a. m. Position N 12° 22′ W 52°

9.07 a. m. Shot the trawl (trawl no. 2); c 113° true. Paid out 7,400 metres cable first 0.4 metres per sec., later increas 0.8.

12.20 p. m. Cable out.

12.40 p. m. Estimated from dynamomete trawl on bottom; depth of trawl metres. Speed during trawling $1^3/_4$

4.20 p. m. Hauling-in begun.

4.40 p. m. Estimated that trawl had l bottom at a depth of 5,033 metre dynamometer readings taken during ing-in.

9.54 p. m. Hauling-in of cable comple

10.06 p. m. Trawl on deck.

Position N 12° 13′ W 51° 44′.

om the echogram, the trawl can be
ned to have traversed an even bottom
een 5,044 and 5,033 metres, and to have
on the bottom for 4 hours.

ure of Bottom: Greyish brown
y found on the otter-boards.

tom Water (St. 362!, N 11° 44'
51° 09', August 2nd 8.30 p. m.): Depth
75 metres, Temp. +1.65° C., Salinity
83 ‰, O_2 4.92 ml/L (sample taken 3
tres above the bottom; O_2 5.34 ml/L 9 m
ove bottom).

ch: According to the preliminary iden-
ication, there were obtained 5 bottom-
nes (*Bathymicrops regis* HJORT & KOE-
ED 1 specimen, *Bassozetus* sp. 2 specimens,
rathrites sp. 1 specimen, and a very
fective Brotulid); one holothurian; two
ge amphipods, probably bottom-forms;
rious worm-tubes of clay and of Globigerina
ells; and a number of *Umbellula* sp., two
which were caught on the 100 m depth-
ark on the main cable, and several on the
idle-line stretcher.

A good number of ordinary pelagic species.

nfortunately, this was our only completely
cessful haul during the interesting second
se, for time did not permit of any increase in
minimum number of trawlings previously
ded upon. Together with the fragmentary
h from Haul No. 6, however, the material
this last trawling has given us a certain
wledge of the previously quite unknown
om-fauna within this part of the western
basin.

fter a few days' interval at St Thomas in
West Indies, course was set towards the
t deep areas of the North Atlantic, in the
e that, by means of some successful hauls
ery deep water, the expedition might be
to contribute to the solving of the problem
o the greatest depths at which living crea-
s can exist. The voyage was directed
narily towards the Porto Rico Deep, in the western part of which lies the Atlantic's greatest deep, at 9,500 metres. With our normal equipment of cable, there was no prospect of reaching the bottom with a trawl at that depth, but by inserting, between the bridle and the main cable, an extra cable 4,000 metres in length and with a diameter of 9 mm, originally intended for deep pelagic hauls, we considered that we should be able to get down to a depth of at least 8,000 metres. On the eastern slope of the Porto Rico Deep, the chart indicated a relatively even bottom at a depth varying between 7,600 and 8,000 metres, and we therefore decided to attempt a trawling there. The echo-sounder, it is true, revealed this bottom as rather uneven, but, since a smooth bottom of corresponding depth was not to be reckoned on in any other place reasonably close to our course, we had, all things considered, to take the risk of losing a trawl for the sake of carrying out a haul at great depth.

Stat. 370. Haul No. 9. Date, August 17th—18th 1948. Wind ENE, 2—3 Beaufort, later increasing considerably; current easterly, about 0.6—0.8 knots.

Check of Bottom: From N 19° 41' W 64° 42', 3.30 p. m., depth about 7,600 metres, sounding was carried out on course 291° true; rather uneven bottom of depth down to fully 8,000 metres, then somewhat shallower again.

6.21 p. m. Change of course for trawling. Position N 19° 49' W 65° 01'.

6.35 p. m. Shot the trawl (trawl no. 2); course at first 96° true, gradually altered more southwards, owing to change of wind-direction. Paid out 11,900 metres of cable; rate at first 0.4 metres per sec., then increased to 0.8.

11.51 p. m. Cable out; trawl, according to dynamometer and angle of cable, then at bottom; depth of trawl about 7,900 metres. Speed during trawling $1^2/_3$ knots. Wind increasing during last hour of haul.

3.55 a. m. (August 18th) Hauling-in begun. Position N 19° 42′ W 64° 44′. Depth of trawl 7,625 metres. No measurement of tension. Very considerable increase of wind and sea during hauling-in, so that eventually the ship could not maintain sufficient speed against the wind and was gradually obliged to bear away and drift downwind at an ever-increasing speed, up to about 3 knots, to which must be added, as far as the trawl was concerned, the hauling-in speed of 0.4 metres per sec.

1.15 p. m. Hauling-in of cable completed.

1.30 p. m. Trawl on deck. (Position N 19° 40′ W 65° 05′).

From the echogram, the trawl can be reckoned to have traversed a rather broken bottom between 7,900 and 7,625 metres, at first perhaps somewhat deeper, and to have been on the bottom for fully 4 hours. Despite the severe strain during hauling-in, the trawl came up whole; wide cracks between the planks of the otter-boards indicated that the wood had been heavily compressed by the great pressure.

Nature of Bottom: Red clay poor in calcium carbonate found on the otter-boards and foot-rope; no bottom-material in trawl except one piece of clinker and two pieces of coke.

Bottom Water: No sample could be taken on account of the high sea.

Catch: The contents of the trawl were slight, and at first sight appeared to consist exclusively of pelagic animals. However, a couple of worm-tubes of clay were evidence that the trawl had been on the bottom and that bottom animals really did exist there. Here and there in the meshes were small gelatinous lumps, which were at first thought to be some kind of small medusae, but which after fixing in formalin revealed themselves as small holothurians, unfortunately very defective, with spicules of *Peniagone* type. Further there were found some l amphipods, likewise badly damaged, coloured with orange-red eyes and a l isopod, very defective, which could be imagined to be bottom-forms, and fragments of a non-tube-building polych

Apart from these, the catch consisted number of pelagic fishes, including a *E pharynx*, of which however almost only skeleton remained, large and small pra a very defective cephalopod, and so or well as some small bunches of Sargasso weed and a number of large fragment plants, apparently caught near the surf since they do not seem to have been mitted to any very great pressure.

It is regrettable that this haul, carried ou least 1,600 metres deeper than any prev haul in the Atlantic, had to take place such unfavourable weather-conditions du the hauling-in that the mechanical strain the catch must have been considerably gre than normal and thus have had a detrime effect on its quality. It is likewise to regretted that the heavy weather did permit us to supplement our trawl-catch haul with the sledge-trawl, as we had h to do. However, this trawling has proved metazoans exist at depths greater than metres.

After this haul at record depth, it se to me obviously desirable to carry out between 6,000 and 7,600 metres, in ord try to get some knowledge of the bottom- between the new record-depth and the d previously known. Course was therefore for the deep areas within the extensive Deep. We hoped that as early as the foll day we should encounter depths of more 6,000 metres, but the whole day the be proved to be completely level at a dep about 5,860 metres, on course 29° true about five in the morning on August 20t bottom began to get irregular, with a ten

ecome shallower, and so we decided to turn
: and utilize the bottom suitable for
ling over which we had just passed.

. 371. Haul No. 10. Date, August
th 1948. Wind NE by E, 1 Beaufort;
rrent easterly, about 1/2 knot.

eck of Bottom: From 7.35 to 8.55
m. on course 209°, flat bottom, depth
860 metres; then a rise in the bottom
llowed by a sinking again until 9.13 a. m.,
d then again a flat bottom, depth 5,860
etres.

a. m. Change of course for trawling.
osition N 24° 12′ W 63° 23′.

a. m. Shot the trawl (trawl no. 3), course
5° true. Paid out 9,500 metres of cable,
te at first 0.4 metres per sec., increasing
0.8, towards the end 0.55.

p. m. Cable out.

5 p. m. Estimated from the angle of the
able that the trawl had reached the bottom;
epth of trawl 5,850 metres. Speed during
rawling varied, average $1^3/_4$ knots.

0 p. m. Began hauling-in.

Position N 24° 28′ W 63° 18′.

No measurements of tension during hauling-in.

58 a. m. (August 21st) Hauling-in of cable
completed.

2 a. m. Trawl on deck.

From the echogram, the trawl can be
koned to have traversed a flat bottom
tween 5,850 and 5,860 metres, and to have
en on the bottom for 4 hours.

ature of Bottom: Red clay poor in
calcium carbonate; no loose bottom-material
in the trawl, but a large number of pieces
of coal, coke and clinker, plus small pieces
of pumice, one fragment of brick, one shark's
tooth, one piece of bone, and a few frag-
ments of shells.

ottom Water (St. 371, N 24° 26′
W 63° 28′, August 21st 5.20 a. m. — 8.12
a. m.): Depth 5,625 metres, Temp. +2.06° C.
Salinity 34.98 ‰, O_2 5.10 ml/L (sample
taken 3 metres above bottom; salinity
34.87 ‰ 9 m above bottom).

Catch: According to the preliminary identi-
fication, there were obtained 1 bottom-fish,
Grimaldichthys profundissimus Roule, which
has thus been caught in all three of the
deepest N. Atlantic hauls in which fish have
been captured at all, but only in those
three; 1 small holothurian; fragments of an
irregular sea-urchin; a crinoid-stem in three
fragments; several large isopods; a number
of worm-tubes; 3 large and 2 small *Um-
bellula* sp.; an actinian on a shark's tooth;
and some small sponges (?).

In addition, the trawl contained various
pelagic species, both fishes and invertebrates.

Further to the north-east, according to the
chart, there were tempting depths of about
6,200 metres and 6,900 metres for the two
remaining trawlings within the deep area, and
course was set for the first-mentioned. Un-
fortunately, our course turned out to be too
westerly, and when this was discovered we were
already a good way north-west of the place
for the projected haul. But on the other
hand we had arrived near a region where the
chart indicated manganese nodules. Professor
Pettersson, the leader of the expedition, had
been interested in these during the whole
expedition, and it was therefore now decided
to obtain some at this place. As I considered
the prawn-trawl too fragile an equipment for
collecting these concretions, I suggested that
a sledge-trawl of Nilsson's pattern should be
used, and this was done. Properly speaking,
this haul with the sledge-trawl falls outside the
zoological investigation, but since a few bottom-
organisms were caught at the same time, a few
technical details of it may perhaps be in place
here.

Stat. 373. Haul with sledge-trawl
for manganese nodules. Date,
August 23rd—24th 1948. The following

information on the haul has been put at my disposal by Prof. PETTERSSON.

6.05 p. m. Change of course for haul with sledge-trawl.

Position N 28° 25′ W 61° 05′.

6.25 p. m. Equipment lowered (sledge-trawl, NILSSON pattern). Paid out 9,000 metres of cable.

9.57 p. m. Cable out.

10.35 p. m. Estimated that the sledge-trawl on the bottom; depth of the trawl 5,500 metres. Speed during haul $1^2/_3$ knots.

11.22 p. m. Paid out a further 700 metres of cable, until 11.57 p. m.

2.31 a. m. Hauling-in begun.

3.10 a. m. Estimated that sledge-trawl had left the bottom; depth at trawl 5,645 metres.

9.05 a. m. Hauling-in of cable completed.

9.15 a. m. Sledge-trawl on deck.

Position N 28° 05′ W 60° 49′.

The sledge-trawl came up with the cross-bars between the runners badly bent and with the large bag badly torn, and all three bags had partly come loose from the frame. From the echogram, the equipment can be reckoned to have traversed a broken bottom from 5,500 metres down to 5,987 metres, and then up again to 5,645 metres.

Nature of Bottom: Red clay, poor in calcium carbonate; masses of manganese nodules and stones as well as a number of sharks' teeth etc in both the extra bags; in the large bag some few concretions and pebbles and a quantity of clay.

Bottom Water (St. 373, N 28° 05′ W 60° 49′, August 24th 9 p. m.): Depth 5,950 metres, Temp. +2.12° C., Salinity 34.95 ‰ O_2 5.14 ml/L (sample taken 6 metres above bottom; salinity 34.86 ‰ 13 m above bottom).

Catch: According to the preliminary identification, the following bottom-animals were obtained: In one of the extra bags, a badly crushed starfish; when the clay in the large bag was sifted, there were found a sn snail, an empty defective snail-shell, a sn transparent mussel and the shell of anotl a worm-tube of lime and a couple of spe attached to concretions, and sponge-fr ments. A couple of amphipods may possibly have been bottom-forms.

During the sifting of the clay, following pelagic species were found: s badly-damaged small fishes, a leptocepha some prawns, amphipods and large copep and some hydromedusae.

After the haul with the sledge-trawl been completed, it was not considered time permitted further search for the deep a that we had not succeeded in finding im diately, and so the two projected hauls b 6,000 metres had unfortunately to be del from the programme, and the journey h commenced. On the way, however, sev opportunities for trawling presented themse Thus while we were steaming to Station on August 27th, the echo-sounder indicat level bottom at a depth of about 5,600 me and so, after the work at that station had completed, we decided to carry out a tra well.

Stat. 376. Haul No. 11. Date, Au 27th—28th 1948. Wind NW, 2 Be current E by S, negligible.

Check of Bottom: From Station at 5.50 p. m., course was set SE bottom even at about 5,575—5,600 m until 7 p. m., and then small irregular Continued on this course until

8.12 p. m. Course changed for trawling

Position N 30° 19′ W 55° 56′.

8.20 p. m. Shot the trawl (trawl no course 309° true. Paid out 7,940 metr cable, rate at first 0.4 metres per sec., increased up to 0.8.

11.35 p. m. Cable out.

11.45 p. m. Estimated from angle of that trawl on bottom; depth of trawl

etres. Speed during trawling about $1^3/_4$ ıots. After trawling had been in progress r about 2 hours, the bottom rose with an ɔparently gentle slope to 5,340 metres, and ıen sank again to about 5,600 metres. 'hen the echo-sounder had given warning ' this, trawling should of course have been scontinued before the trawl reached the ɔpe, but bearing in mind our experience of ·ıccessful trawling over the uneven bottom ; Station 370, and also the likelihood that ı a slope like this we might obtain bottom-ıimals different from those living on a flat ottom, I resolved to continue trawling for ıe full period.

) a. m. (August 28th) Hauling-in begun; no ension-measurements.

5 a. m. Hauling-in of cable completed.

'osition N 30° 30′ W 56° 19′.

Both bridle-lines had broken near the tter-boards, and the whole trawl had been ɔst.

t is probable that, on the incline up which trawl had been towed, the bottom was y uneven, with stones and boulders be-·en which the otter-boards had jammed.

ture of Bottom: Red clay with letritus of foraminifera; stone.

ttom Water: Not taken at this tation; for nearest sample see Station 373 the haul with sledge-trawl).

tch: Despite the fact that whole trawl vas lost, yet a small catch was obtained of ɔottom-invertebrates; on the stretcher be-ween the bridle-lines were caught 4 *Um-ɔellula* sp., of various sizes, and 4 antipa-harians (*Bathypathes lyra*?), one of them ıttached to a small stone.

The next opportunity for trawling did not ·sent itself until September 3rd, when an ·n bottom was encountered at a depth of out 4,900 metres. Before the haul was gun, we tested the spare otterboards we d brought with us, which had been fitted to our one remaining trawl (no. 2). When the trial lowering was made, however, it appeared that the chains of the boards had been incorrectly fitted, with the result that the otter-boards canted upwards and skipped along the surface of the water; and so a hasty adjustment of the chains was undertaken.

Stat. 384. Haul No. 12. Date, September 3rd 1948. Wind S, about 3 Beauf.; current NE, about 1/2 knot.

Check of Bottom: made while steaming towards the station.

Position N 36° 19′ W 43° 04′.

12.53 p. m. Shot the trawl (trawl no. 2, new boards); the otter boards still swung upwards a little, but it was thought that the trawl would be forced to the bottom by the weight of the cable. Course due south. Paid out 7,100 metres of cable, rate at first 0.4 metres per sec., then increased to 0.8.

3.45 p. m. Cable out.

4.10 p. m. Estimated from angle of cable that trawl had reached bottom; depth at trawl 4,900 metres. Speed during trawling about $1^3/_4$ knots.

5.40 p. m. Hauling-in begun, since bottom showed irregularities and tendency to shoal. No tension-measurements during hauling-in.

10.25 p. m. Hauling-in of cable completed.

10.34 p. m. Trawl on deck.

Position N 36° 02′ W 43° 03′.

The trawl contained only a number of pelagic organisms; no bottom-material was found on the boards or in the trawl, which had apparently never been on the bottom. The adjustment of the otter-board chains had not been completely satisfactory, and the boards had probably forced the trawl upwards.

Haul No. 12, consequently, failed completely.

It follows that the disregard of the warning of the echo-sounder, during Haul No. 11, had contributed indirectly, through the loss of the

otter-boards, to yet another failure. But in the hope that one or more further opportunities for trawling might yet present themselves, our expedition's mechanic, Mr A. JONASSON, carried out a careful adjustment of the chains of the new otter-boards.

Fortunately, another opportunity for trawling arose before we had left the West Atlantic Deep Basin.

Stat. 387. Haul No. 13. Date, September 7th 1948. Wind N, 2—3 Beauf.; current ESE, about 3/4 knot.

Check of Bottom: made by steaming a distance suitable for trawling; depth about 4,600 metres.

9.40 a. m. Altered course for trawling.

Position N 40° 33′ W 35° 24′.

10.04 a. m. Shot the trawl (trawl no. 2); course 307° true. Paid out 6,000 metres of cable.

12.36 p. m. Cable out; held trawl off the bottom by steaming at 2 knots.

1.45 p. m. Estimated that the trawl was now above the even part of the bottom; paid out a further 600 metres of cable until 2 p. m.

2.30 p. m. Estimated from angle of cable that trawl on bottom; depth of trawl 4,590 metres. After 2 hours' trawling, the bottom gradually rose to 4,540 metres, then sank again to 4,600 metres at the end of the haul.

6 p. m. Hauling-in begun; no tension-measurements.

10.30 p. m. Hauling-in of cable completed.

10.45 p. m. Trawl on deck.

Position N 40° 34′ W 35° 52′.

From the echogram, the trawl can be reckoned to have traversed an even bottom between 4,590 and 4,600 metres, with one slight rise to 4,540 metres, and to have been on the bottom for nearly 4 hours.

Nature of Bottom: According to the EKMAN core-sampler, argillaceous Globigerina ooze; no bottom material in the tr apart from 1 piece of clinker, 2 pieces coke and one fragment of pumice.

Bottom Water (St. 387, N 40° W 35° 52′, September 7th 11.11 p. m.—S 8th 1.35 a. m.): Depth 4,520 metres, Te +2.38° C., Salinity 34.93 ‰, O_2 5.74 m (sample taken 5 metres above the bott

Catch: According to the preliminary ide fication, there were obtained at leas bottom-fishes [*Nematonurus armatus* (H TOR) 1 large specimen, *Chalinura sim* GOODE & BEAN 1 specimen, *Bathypte* sp. 6 specimens, *Leucochlamys* sp. 1 sp men]; a couple of holothurians; an arm Brisingid; a couple of small *Scalpeli* bryozoans; several polychaetes, some them in tubes; *Umbellula* sp., large small; and hydroids. In addition, on on the drags of the bridle-line stretcher, t was a densely-packed cluster of anim which turned out to consist of holothur (*Protankyra* sp.), gephyreans (*Phascolos flagriferum*?), a number of polychaetes, a free-living nematode. As usual when trawl was examined and emptied by artif light during the night, a re-examination undertaken in the morning, and then dicovered among other things some b zoans, one pycnogonid, unfortunately de ive, and a small antipatharian (*Bathyp lyra*?), all dry.

Of pelagic organisms, the catch conta a number of small fishes and fish-la prawns, *Sagitta*, nemerteans, siphonopl and medusae.

This haul, the last undertaken west o Central Ridge, should consequently be c dered the richest during the whole exped from the point of view of the numb species of bottom-animals, perhaps owi the fact, that the trawl had worked ov ridge on the bottom.

There was however one more opportunity carrying out a trawling on the homeward ey.

401. Haul No. 14. Date, September 15th 1948. Wind WNW, 1 Beaufort; current at first negligible, later E by S, tty strong.

ck of Bottom: Carried out on mal course; even bottom at about 5,000 tres for 1 hour 20 minutes steaming.

a. m. Change of course for trawling.

osition N 43° 40′ W 18° 45′.

a. m. Shot the trawl (trawl no. 2); urse 225° true. Paid out 7,200 metres of ble, rate at first 0.4 metres per sec., reasing to 0.8.

a. m. Cable out.

a. m. Estimated from angle of cable at trawl on bottom; depth of trawl 5,000 tres. Speed during trawling $1^3/_4$ knots.

a. m. Began hauling-in, since the current d carried the ship off course, and the ho-sounder indicated a sharply-broken ttom. No measurements of tension.

p. m. Hauling-in completed.

p. m. Trawl on deck; one wing twisted.

osition N 43° 24′ W 18° 59′.

om the echogram, the trawl can be oned to have traversed an even bottom ween 5,000 and 5,025 metres and to have on the bottom a bare three hours.

ture of Bottom: On the otterboards, volcanic Globigerina ooze, anisopic sand, Radiolaria and sponge spicules; bottom-material in the trawl apart from large number of small pieces of pumice.

ttom Water (St. 400!, N 43° 04′ 19° 40′ September 14th 7.15—10.31 a. m.): epth 6,005 metres; at 4,880 m Temp. 2.71° C., Salinity 34.93 ‰, O_2 5.17 ml/L ample taken 1,225 metres above the ottom).

tch: According to the preliminary identification, there were obtained 4 bottom-fishes (*Bathypterois* sp. 2 specimens, *Echinomacrurus mollis* ROULE? 2 specimens); one holothurian; one defective *Freyella* sp.; one ophiurid; one large amphipod (orange-red, probably a bottom-form); one large polychaet; one sponge; and specimens attached to some of the pieces of pumice.

The catch of pelagic animals was also rather small: a few *Cyclothone*; a few prawns, various species; a small nemertean; ctenophores; medusae; and so on.

The quantitatively poor catch on this our last haul may possibly have resulted, apart from the reduced time, from the fact that one wing of the trawl got twisted and that the trawl thereafter worked inefficiently.

The most important data for the hauls with prawn-trawls and the haul with the sledge-trawl, treated in detail above, are assembled in the appended table. For the positions of the trawling-stations, reference may be made to the map appended.

Some General Results

During the time that could be allotted to the marine zoological investigations on the last Atlantic stage of the Swedish Deep Sea Expedition, in all $8^1/_2$ working days, there were carried out 14 trawlings, all at depths greater than 4,000 metres, of which 10 obtained catches of bottom-animals: that is, a good 70 % of the hauls were successful, as against 65 % for the trawlings of earlier expeditions at corresponding depths. In itself, of course, this is a good result, and it undeniably appears even more favourable when it is considered that our equipment was of greater size, which naturally made it more difficult to handle. Furthermore, our expedition succeeded in trawling at a greater depth than any earlier one, and thereby in moving down the hitherto known occurrence of bottom-animals by at least 1,600 metres,[1]) which is an achievement

[1]) Cfr. the foot-note, p. 5.

of interest both from the point of view of trawling-technique and of biology generally. As a general result, prominence should also be given to the improvement of deep-water trawling-technique, which arose out of the experience of the expedition, but which above all was attained by the use of the self-recording echo-sounder (partly for reconnoitring for a suitable bottom, partly for giving informa about the depth at which the catches made), and also by the use of the diag drawn up by KULLENBERG for determinin requisite length of cable.

For the zoological results proper, refer should be made to the works by the va specialists on their respective groups of ani

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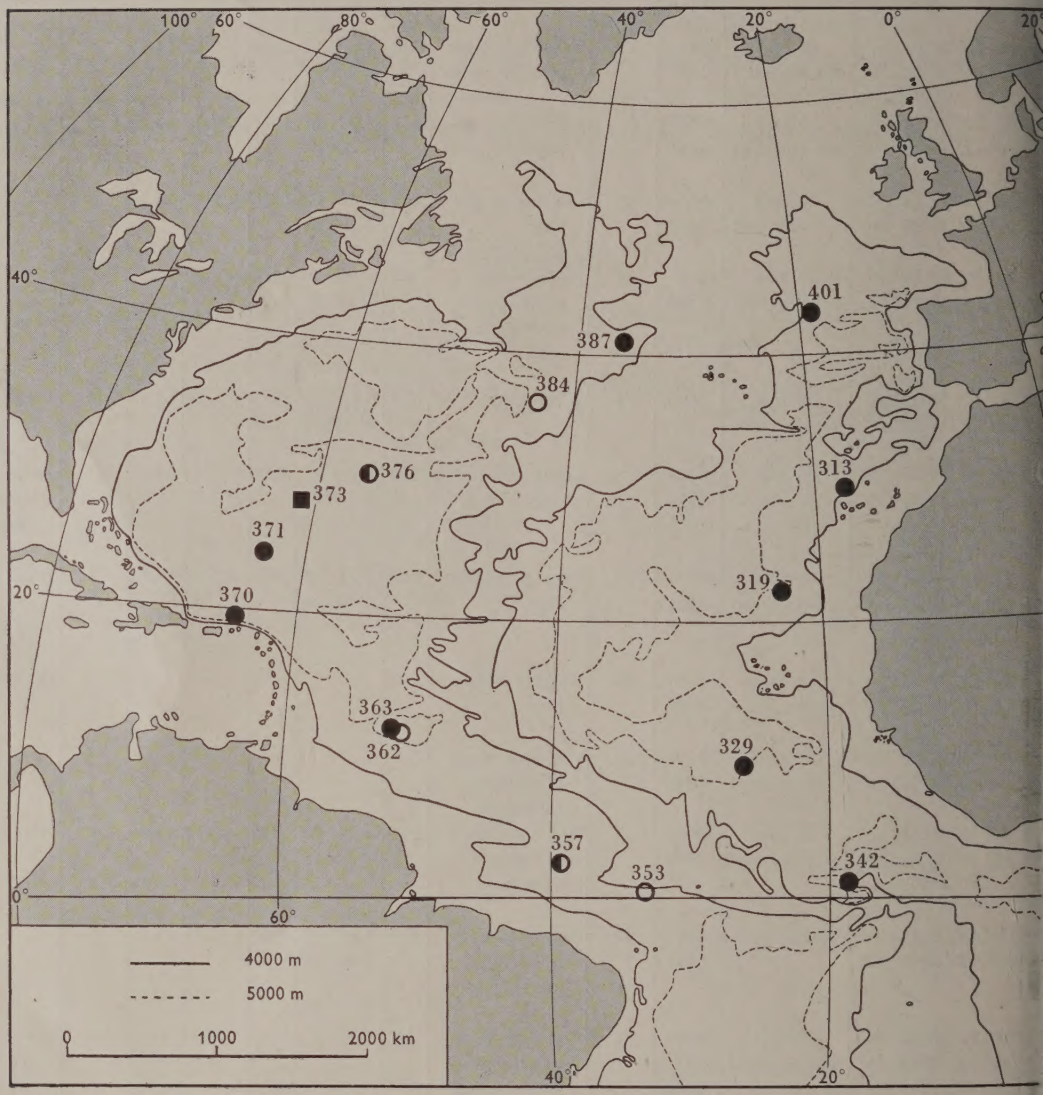
LIST OF TRAWLING STATIONS

Position	Gear	Depth of haul in m	Duration of haul in hours	Nature of bottom	Hydrographical observations						Remarks
					Stat. No.	Position	Depth in m	Temp. in °C	Salinity in ‰	Sample taken m above bottom	
N 29° 48′ W 17° 39′– N 30° 05′ W 17° 18′	30 feet prawn-trawl	4267— 4255	4½	Yellowish Globigerina ooze	314	N 29° 48′ W 17° 27′	4290	+ 2.42	34.89	6	
N 22° 31′ W 23° 28′– N 22° 41′ W 23° 10′	30 feet prawn-trawl	4872— 4867	3¾	Yellowish Globigerina ooze	319	N 22° 31′ W 23° 28′	4935	+ 2.45	35.03	6	
N 09° 38′ W 26° 20′– N 09° 50′ W 26° 30′	30 feet prawn-trawl	5610— 5600	3½	Calcareous red clay	328	N 10° 12′ W 26° 36′	5360	+ 2.35	34.87	3	
N 01° 03′ W 18° 40′– N 00° 58′ W 18° 37′	30 feet prawn-trawl	5250— 5300	4	Fairly loose, argillaceous Globigerina ooze	342	N 00° 59′ W 18° 37′	5260	+ 2.28	34.85	7	
N 00° 15′ W 33° 46′– N 00° 16′ W 33° 25′	30 feet prawn-trawl	4570	4	Loose clay	353	N 00° 16′ W 33° 40′	4575	+ 0.92	34.75	5	Trawl-bag lost, no bottom animals.
N 02° 26′ W 39° 26′– N 02° 24′ W 39° 12′	30 feet prawn-trawl	4474— 4430	3	Loose calcareous clay	357	N 02° 25′ W 39° 17′	4445	+ 1.28	34.77	4	Trawl twisted inside-out and tangled up.
N 11° 45′ W 51° 29′– N 11° 44′ W 51° 09′	30 feet prawn-trawl	5017— 5010	2½	Greyish brown clay	362	N 11° 45′ W 51° 29′	4975	+ 1.65	34.83	3	Trawl probably not at bottom, no bottom animals.
N 12° 22′ W 52° 00′– N 12° 13′ W 51° 44′	30 feet prawn-trawl	5044— 5033	4	Greyish brown clay	—	—	—	—	—	—	For hydrography see st. 362
N 19° 49′ W 65° 01′– N 19° 42′ W 64° 44′	30 feet prawn-trawl	7900— 7625	4	Red clay, poor in calcium carbonate	—	—	—	—	—	—	
N 24° 12′ W 63° 23′– N 24° 28′ W 63° 18′	30 feet prawn-trawl	5850— 5860	4	Red clay, poor in calcium carbonate	371	N 24° 26′ W 63° 28′	5625	+ 2.06	34.98	3	Salinity 34.87 ‰ 9 m above bottom.
N 28° 25′ W 61° 05′– N 28° 05′ W 60° 49′	Sledge-trawl	5500— 5987	4½	Red clay, poor in calcium carbonate	373	N 28° 25′ W 61° 05′	5950	+ 2.12	34.95	6	
N 30° 19′ W 55° 56′– N 30° 30′ W 56° 19′	30 feet prawn-trawl	5600— 5340— 5600	4	Red clay with detritus of foraminifera	—	—	—	—	—	—	Trawl lost; some few animals on the stretcher between the bridle-lines.
N 36° 19′ W 43° 04′– N 36° 02′ W 43° 03′	30 feet prawn-trawl	4900— 4880	1½	—	384	N 36° 25′ W 43° 01′	4790	+ 2.30	34.98	—	Trawl not at bottom, no bottom animals.
N 40° 33′ W 35° 24′– N 40° 34′ W 35° 52′	30 feet prawn-trawl	4590— 4540— 4600	4	Argillaceous Globigerina ooze	387	N 40° 34′ W 35° 52′	4520	+ 2.38	34.93	5	
N 43° 40′ W 18° 45′– N 43° 24′ W 18° 59′	30 feet prawn-trawl	5000— 5025	3	Volcanic Globigerina ooze, anisotropic sand, radiolaria and sponge spicules	400	N 43° 04′ W 19° 40′	4880	+ 2.71	34.93	1225	Bottom 6005 m



Trawling Stations of the Swedish Deep-Sea Expedition.

Haul with 30 feet prawn-trawl: ● *successful haul,* ◐ *unsuccessful haul but with s catch of bottom animals,*
○ *unsuccessful haul, no catch of bottom animals.*

Haul with sledge-trawl: ■